

# Relevance of Prospect Theory to Transport Choice Modeling: a Rejoinder<sup>a</sup>

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I was pleased to see that van de Kaa spelled out my comments on prospect theory and must have spent quite some time tracing back the references and conducting some additional qualitative research. The very purpose of my contribution to the workshop and the paper was to stimulate discussion and it seems to have succeeded in that regard.

Unfortunately, the result of van de Kaa's effort is a largely unstructured piece of work that touches on many different issues. A detailed response to each point (many qualify for such a response) would take many pages and the same unstructured set-up and I have no desire to do so as many points would require a detailed contextual expose, justification of interpretations and elaboration. This rejoinder therefore addresses the main train of thought. Even after careful re-reading, however, I have difficulty understanding the precise motivation, tone and intention of his reaction. It is clear that he identified mistakes in the references, signaling that these mistakes were not filtered out by the database in my group, nor by the reviewers, not by any systems that the journal itself may have. I stand corrected – may the reader benefit.

Beyond that, van de Kaa's main concern seems to be that “most critical comments in the paper appeared to be <my> personal opinions without solid theoretical or empirical support”. I have no need to contend this qualification: the paper is exactly that – nothing more, nothing less! In fact, on page 370, 3rd paragraph, I explicitly mentioned the context of the paper: I was invited for the workshop that led to the special issue to voice critical comments about prospect theory to stimulate the discussion. The criticisms were therefore phrased such as to trigger the audience to critically think about the theory and the way it has been applied in travel behavior research to date, to provide input to the discussion and/or conduct empirical research (to the extent possible as not all arguments lend themselves for empirical research). Illustrative examples were therefore also based where possible on research of other attendees. The arguments are not based on any thorough historical exegesis of (accumulated) prospect theory and a reconstruction of the development of the theory and its (non-)reception in different disciplines. Rather, it is based on my personal mental representation of the pros and cons of this theory, developed across decades from my days in marketing and consumer science based on earlier discussions in workshops, dozens of papers about prospect theory that I processed as editor or conference organizer, and independent critical thinking. Considering this nature of the invitation, no attempt was made to add nuances or to be comprehensive – it is not a resource paper, not a detailed literature review, not a meta analysis. This should sufficiently qualify the comments made in section 3 of van de Kaa's comments and put these into the right context. I fail to see however that the fact the paper

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<sup>a</sup> Note from Caspar Chorus (Editor-in-Chief): the paper “Relevance of prospect theory to travel choice modeling: A rejoinder” was written by Harry Timmermans in response to the paper “Timmermans' misleading critique of Prospect Theory actually supports its relevance for travel choice modelling”, written by Evert Jan van de Kaa (and published in this issue). Both papers have not been reviewed by me nor by external referees, to ensure that the papers would remain completely representative of the authors' own opinions.

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expresses personal opinions can be turned into support for the relevance of prospect theory to travel choice modeling as the title of van de Kaa's comments suggests.

Implicitly, van de Kaa seems to argue that only a detailed historical account, based on solid (which is not defined) theoretical or empirical support is academic, and anything else is inferior. As this touches upon a methodological discussion and goes beyond the scope of this journal, I will not comment on the argument in this rejoinder. Let me suffice to say that I disagree, and that it would be counterproductive to reflections about the state of the art and formulating research agendas. Again, the paper was not meant to give a summary overview of the balance of evidence of empirical support of prospect theory – it was meant to stimulate thinking about its (ir)relevance to different aspects of travel behavior research.

To get some structure behind the loose set of comments on (accumulated) prospect theory and set the stage to compare it with econometrically based discrete choice models, I started with a conceptual framework that I find useful to position the various models of choice and decision making that have been suggested over the years and with a formal underlying representation using expected utility theory (expected value model) as a reference. Dominant theories on choice behavior such as information integration, probabilistic choice theories, random utility theory, decompositional preference theory, satisfaction and evaluation theory and with some imagination even various attitudinal theories can all be explained, categorized and discriminated in terms of this framework. I considered this useful because it allows the classification of alternative theories in terms of objective vs. perceptual representations, linear vs. non-linear value judgments, deterministic vs. stochastic value judgments (utility functions) and deterministic vs. probabilistic choices: issues that were picked up later on in the paper. Moreover, this framework served to position and classify the work on prospect theory in travel behavior research, reflecting how scholars in travel behavior research have applied the theory in their formalized model specifications. Van de Kaa seems to somehow have misconstrued this part of the paper as a discussion of prospect theory in its widest arguments. His reaction also seems to indicate that he has been insufficiently aware of modeling assumptions that need to be made and their theoretical implications. Consequently, Section 1 of his paper is ill-founded and logically therefore his suggestion of fabrication is unwarranted: if there is any fabrication, it stems from the fact that van de Kaa is trying to interpret my representation from a not-intended and misplaced perspective. As a consequence, rather than becoming involved in a constructive discussion to better identify the adequacy of prospect theory relative to competing theories and associated modeling approaches, his counter-argument seems to be that prospect theory potentially can deal with (almost) every behavioral process (under risk and uncertainty) which does not seem a productive stance.

In order to stimulate the discussion on the boundaries of (accumulated) prospect theory, my main point, that runs through the paper, is that activity-travel behavior differs in some fundamental ways from gambling and similar types of behavior for which prospect theory has been originally advanced/to which it has been predominantly applied: travel behavior represents repeated (vs. one time only) choice, it is context-dependent, it often has low consequences and moreover any negative consequences can be easily remedied, travellers learn (vs. gambling represents pure chance), outcomes and their probabilities are not given and fixed (but are mentally construed as part of travellers belief systems and may change over time), probabilities are departure and route choices are embedded in daily schedules (as opposed to stand-alone choices), it represents a form of routine as opposed to high involvement behavior, etc. etc. Because (accumulated) prospect theory does not explicitly include the concepts to characterize this very nature and complexity of activity-travel decisions and in its original and still dominant form (at least in the derived models) lacks the critical mechanisms and therefore the sensitivity to represent the quintessence of activity-travel scheduling decisions in any comprehensive way, I emphasized the limitations of prospect theoretical approaches in

predicting daily activity-travel patterns. Competing approaches have more to offer in terms of content validity in this context! It seems to me that my arguments are more fundamental and go much beyond what van de Kaa has read “Yet the only arguments in T that support PT’s inferiority for transport research compared to Bayesian learning models concern its inability to update references between recurrent choices”. In fact, this is just a minor issue.

Thus, if we unpeel prospect theory from its wider interpretations that van de Kaa, both in his reaction and dissertation, seems to embrace, I argued that what is left is the curvature of the model, including the reference points (indeed - in reaction to Section 3.7 - used in a mathematical sense only to depict any bifurcation in the value judgment, utility function or choice model because different models use different concepts; this can be a single one or multiple ones (one for every attribute) as in Zhu and Timmermans). I continued saying that indeed the notion of regimes in the value function is interesting and that the actual shape can be empirically tested. However, I also emphasized that the curvature itself does not rule out any competing theories of choice under uncertainty, and I mentioned some examples of models, admittedly mostly from work conducted in my group, that have a similar flavor, but were derived from different theories, and are based on a richer, econometric modeling tradition (a secondary line of argumentation in the paper is that most work on prospect theory in travel behavior research has not made the usual modeling assumptions). Section 3.4 in van de Kaa’s reaction suggests that I have not been very successful in communicating this argument to him. Section 3.6 even suggests that he seems ignorant of the issues: “A thorough examination of all these articles revealed that genuine human error was the best explanation for people’s choice of different alternatives from the considered recurrent identical choice sets. PT does not explicitly discuss human error in connection with choice”: this was exactly my point as one example why a richer modeling approach seems warranted! Whether the resulting models will still be derived from prospect theory or some utility theory does not really matter – the multinomial logit model is commonly interpreted in terms of random utility theory but can also be and in fact has been derived from several other theories. Empirical evidence of the predictive success of the model itself does not say much necessarily on the validity of the underlying theory. What I hinted at is that the curvature, which van de Kaa argues is the quintessence of prospect theory, can also be derived from some competing theories – in the meantime it has been shown in a forthcoming TRB paper (Zhang, Yu and Timmermans, 2013) that it can be derived from relative utility theory.

This difference in perspective continues in section 3.5, which argues that I should have referenced his dissertation. This statement assumes that as a member of his committee, I have read every single page of his dissertation carefully as opposed as judging whether it globally meets the minimum requirements, and that I remember its full contents or checked his dissertation again when writing the paper for the workshop. The answer to all these assumptions is negative, but more importantly, the argument is not relevant. My comments about shifting reference points do not deal with the issue discussed in Section 3.5 of van de Kaa’s comments that “... participants received feedback about the outcomes of their previous choices in the sequence respondents receive”. In contrast, my argument is an elaboration of the general argument that other theories and model are richer in their conceptualization. In particular, it refers to models of dynamic activity-travel behavior and associated learning, including our work on learning and dynamic aspiration levels, all published long before van de Kaa’s dissertation, which in turn are founded in more basic theories. I can only wonder why the comment is made – upon close reading, the two quotes clearly are unrelated and point at different issues.

Most of van de Kaa’s remaining arguments seem a repeat of his earlier arguments. Once more, the contention of my contribution to the workshop as reflected in the paper is that (accumulated) prospect theory offers a sound and valuable approach to especially those choice processes in travel behavior that are sufficiently congruent with its critical assumptions as it has proven its usefulness in several other disciplines: uncertainty, clear gains and losses, simple problems, etc.

Examples would be pricing, travel information and the like. The state of the art in applications of prospect theory would benefit I argued by improving modeling rigor in these applications as it is typically associated with models derived from competing theories. Whether this then is called a prospect theoretical model or a relative utility model or just a reference-based model is a non-issue from a modeling perspective if the purpose is to predict actual choices. However, in case of routine departure time and route choice, the question is whether these choice problems meet assumptions and reasoning behind prospect theory. Interestingly, Kahneman and Tversky themselves in their 1983 APA keynote address argued that “loss aversion effects unlikely play a significant role in routine economic exchanges”. Shouldn’t travel be considered as equivalent to such routine economic exchanges? Isn’t it simply a cost that people need to pay because they have commitments? In any case, I find other models and underlying theories more appealing for the development of the new generation of comprehensive models of travel demand, which predict how dynamically individuals and households organize their activities and associated travel in time and space under conditions of uncertainty, with an abundance of information as part of social networks. Ironically, the rare instances where van de Kaa seems to agree with my arguments amplify the very quintessence of my main argument and define what I see as the boundaries of the relevance of prospect theory to travel demand forecasting and travel behavior research.